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July 1988
Working Paper #2034-88

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ABSTRACT

International trends toward collaboration among firms in the development and commercialization of new technology are most evident in biotechnology. The optional forms of collaborative approaches -- research contracts, minority equity investments, technology licensing, corporate alliances and joint ventures, and acquisitions --are discussed in this article, with specific reference to their applicability in the biotechnology industry. Japanese practices in these areas are reviewed in depth, discussing the rationale for Japanese preferences in the use of inter-firm collaboration and presenting synopses of Japanese industrial data gathered on 100 firms involved in biotechnology.

KEYWORDS

Collaborative R&D; new ventures; contract research; venture capital; licensing; corporate alliances; joint ventures; acquisitions; biotechnology; Japanese management approaches.

The Need for Collaboration in Biotechnology

World-wide research, development and commercialization of new technology-based products and processes are characterized increasingly by collaborative undertakings among multiple organizations. (Fusfeld and

Haklish, 1985; Roberts, 1988) "Alliances" among firms, and consortia linking industry to universities and/or government laboratories are growing in number and importance in fields ranging from microelectronics to software to advanced materials to biotechnology. (Dimanescu and Botkin, 1986) In the biotechnology industry collaboration among firms is essential. (Shan, 1987; Pisano, 1988) Biotechnology investments are almost always high risk, with the potential for high return, and they require large capital outlays. A long lead time is needed before product commercialization can occur, consequently financing must also be long term and stable. Small startup firms, which have advanced gene manipulation technologies, cannot finance research and development without assistance from investors that include large operating corporations and venture capital firms.

To develop biotechnology products, several technologies often have to be combined. For example, in developing pharmaceutical products recombinant DNA technology may be required for cloning, and fermentation for scale up and production. For the development of biosensors, microelectronics technology is combined with biochemical and biomedical technology. Hybridization of the latest gene technologies with conventional technologies is needed for advances in many other life science related industries including chemicals, agriculture, dairy and fisheries. However, very few firms yet have the comprehensive technologies and expertise required to develop these products totally inhouse.

Even after successfully developing a new biotechnology product, startup firms still need special distribution channels, marketing skills, and an effective sales force to market their products. In the pharmaceutical business new products also have to go through many phases of government regulated clinical trials and approvals. The cost of clinical trials and of developing sales and marketing channels is extremely expensive; for the small biotechnology startup these costs would be prohibitive without significant venture capital backing and/or industrial collaborators.

To achieve successful commercialization biotechnology firms have learned quickly that they must complement their strengths through inter-firm collaborations. While biotechnology startups have advanced technology, they usually lack research and development funds, strong existing conventional

technologies that can be combined with new high technology, market channels and other business expertise. On the other hand although large firms are not typically strongest in leading edge technologies, they usually have the remaining requirements for commercializing biotechnology developments. Collaborations have become as popular as they are important and an alliance map of the biotechnology industry looks like a spider web where a single company is involved in many types of relationships with many different partners. (An example of such an "alliance map" appears in Technology Strategies, January 1988.)

Japanese Biotechnology Collaboration

Growing world interest in how the Japanese manage technological innovation has followed the continuing success pattern of Japanese industrial penetration and domination of advanced technology industries, like consumer electronics, semiconductors, ceramic materials and other areas. An aspect of the Japanese organizational approach to research and development management that has received special attention has been the effective conduct of government-initiated multi-firm joint R&D projects, such as the noted successful venture in Very Large Scale Integrated (VLSI) semiconductor development, organized by the Japanese Ministry of International Trade and Industry (MITI). (Sakakibara, 1983) More recently researchers have been assessing broader aspects of Japanese R&D collaborations, most often not organized by governmental agencies although frequently with government encouragement. (Kurokawa, 1987; Samuels, 1987)

This article reports on the evolution of collaboration strategy in the Japanese biotechnology industry, based on the study of over 100 Japanese companies that are involved in biotechnology business. The apparent standard strategic collaborative pathway that Japanese firms have been taking follows closely the entry steps followed by Monsanto into biotechnology (see Roberts and Berry, 1985) and now being pursued by many other Western chemical and pharmaceutical firms. The four general stages of external technological collaboration are discussed below in terms of their overall strengths and weaknesses. Companies that become serious in their diversification efforts of course integrate these external involvements with growing internal research and development efforts as well as internal venture activities. Each

stage is distinguished in terms of the degree of managerial and organizational commitment and expected accumulation of technological expertise. (See parallels to earlier U.S. company use of new venture approaches as discussed in Roberts, 1980.)

Stage 1. Research contracts (and minority investments)
Stage 2. Licensing
Stage 3. Corporate alliances
Stage 4. Acquisitions

The remainder of this article will discuss the strategic implications of each option, present the data collected on current Japanese practice, and provide a focus on Japanese companies' strategic implementation of collaborative approaches.

Research Contracts (and Minority Investments)

Research contracts with biotechnology startup companies are among the first steps usually taken by large corporations in attempting to enter the new business. Companies which have just become interested in biotechnology are rationally trying to learn technologies and search out opportunities in the new area without initially making much commitment or taking much risk. Research contracts provide a conservative low-risk option to begin participation in some aspect of the biotechnology industry, obviously limited by the target area of the research, with prospects for low to moderate financial returns. These contracts provide a specific window on technology quickly and easily, although they do not help the funding companies to accumulate very much expertise.

Equity investments in biotechnology startups may alternatively serve "window on technology" purposes as do research contracts. Many U.S. large firms that are evaluating or initiating diversification into the biotechnology industry invest equity in startups as well as contract out research. However, as we indicate in this section, the minority investment strategy is not commonly used by large Japanese companies.

Research Contracts

Research contracts are agreements in which sponsoring firms will get usually exclusive licensing rights of new inventions from contract research activities in exchange for providing research funds to startups for special or general research topics. Exclusive licenses are sometimes limited to a certain geographical area or just to marketing and sales rights. Patents arising from the research are typically reserved by the startups.

Contract research is a low-risk / low-return strategy in comparison with inhouse research or acquisitions. Research contracts can be used by large corporations to secure a window on technology at relatively low cost. Kenney indicated that many large corporations are investing money merely to discover the potentials of biotechnology and therefore they do not care much about the result of contract research. He noted, "For MNCs, this probationary investment will lead to a corporate decision to either seek greater involvement or to abandon any further efforts to enter the field." (Kenney, 1986, p. 207)

Research contracts also allow corporations that have already moved into this new technology to diversify research into new areas quickly and easily. As product lead times are very long in the biotechnology industry large firms can save significant amounts of time and money through the use of outside contractors with expertise. Large firms can form a research "portfolio" flexibly by contracting out many kinds of research to different startups that have the most advanced technologies in their areas. Thus firms can diversify into many unfamiliar fields of technologies without expanding inhouse R&D staffs and facilities. What they need is only a relatively limited amount of contract funds. The problem in implementing this approach is the lack of inhouse expertise to judge either a potential contractor's capability or the technical and commercial promise of the proposed research.

Another advantage for large firms is that contracts with startups can be kept confidential if the contracting company is privately held. Even contracts with public firms can be kept relatively secret in comparison with university research contracts which almost inevitably include publication rights for the academic scientists and open access. (Kenney, p. 206)

For small biotechnology startups research contracts are also important because large capital outlays are required to support their research activities. Maintaining a high level of research activity often causes funding shortages and forces startups to sell pieces of their research capacity, their only real competitive advantage. (Kenney, p. 158) While startups have to compete, in a way, to get better research contracts in order to solve financial problems, large firms also have to compete among themselves to generate contract research relationships with the better startups with more promising technologies. (Kenney, p. 207) And while small firms try to sustain their bargaining power by not selling their most important research abilities to their potential competitors, large corporations also try to do the same thing by not giving too much financial support to their potential competitors. Thus, with all of the bargaining points on each side, whether the large firm or the small is more dominant depends on the specifics of each case. Often neither firm appears to dominate.

Firms' Contracting Strategy. Major Japanese firms diversifying into biotechnology contract out research mainly to U.S. startups. These firms contracting to U.S. biotechnology ventures range from pharmaceutical companies to chemical companies and food firms. The major advantage of this option for Japanese firms is the quick access to the advanced technologies. Especially in the early stage of biotechnology evolution, Japanese firms were struggling to find good research partners to learn what the emerging technology was. As all Japanese firms entered the biotechnology business after the leading U.S. startups, some of them beginning as late as the early 1980s, getting access to the new technology and initiating technology transfer was an emergency issue.

By practice data on many research contracts are kept confidential, so not many examples are available. Table 1 presents some that are known publically; the actual number of Japanese biotechnology research contracts is estimated to be far greater. (Kumagai, 1988)

From the small company's perspective it must be very careful not to overextend itself in too many research contracts which dilute its most important competitive advantage, technological superiority. Over-dependence

Table 1. Major Japanese Biotechnology Research Contracts

Japanese Company	Contractor	Research Topic
CST Research	Biogen	Factor 8th
Fujisawa Pharmaceutical	Biogen	TPA
Green Cross	Collaborative Research	IFN
	Biogen	HBsAg
	Genex	Albumin
Meiji Seika	Enzo Biochemical	Monoclonal Antibody
	Biogen	DNA Technology
Mitsubishi Chemical	Genentech	Albumin Serum
Mitsui Toatsu	Genex	DNA Technology
Shionogi	Biogen	Alpha-IFN, IL2
Sumitomo Pharmaceutical	Biogen	GM-CSF
Teijin	Biogen	Factor 8th
Toyobo	Integrated Genetics	EPO
Yamanouchi Pharm.	Genex	TPA
Yoshitomi Pharmaceutical	Panlabs	DNA Technology

Source: Authors Compilation

on contract research also results in an unstable income base. Although research contracts solve short term financial problems, the forward looking startups know that no firm can survive merely on royalties in the future. Genentech, for example, in contrast to Cetus, has been very conservative in accepting offers for contract research. Instead, Genentech has emphasized the need to manufacture products and gain important experience in conducting clinical trials on its own. (Kenney, pp. 160-161)

Minority Investments

For large companies simply providing research contract support to the

startup provides little insight into a leading edge technology, although it may generate a saleable product or a fractional share of the contractor's future revenue stream. In search of a better insider view of new technology and/or new market opportunities large corporations will often purchase equity shares in biotechnology startup companies, frequently in addition to signing research contracts and licensing agreements. Ownership allows larger corporations a claim on the management of startups, though often an unrealizable claim! The benefits from these equity investments are often expected by the investing company to increase according to the percentage of equity owned.

Minority investment provides a potentially ideal opportunity to have a closer look at a new technology and business because the investment magnitude is usually considerably smaller than even the initial costs of developing inhouse research facilities or making an acquisition. In order to get a better view on the technology and an opportunity in a new business, a large firm will sometimes purchase enough equity to obtain a seat on the startup's board of directors. (Tax laws and accounting regulations sometimes act to constrain the percentage of equity sought by the large firm.) This strategy also allows the large firm to establish a base for a possible acquisition takeover in the future. (Kenney, p. 207)

Making minority investments is just like buying a call option in biotechnology. When the new technology becomes successful in the future, large firms can claim benefits from the investment. Equity involvement secures some of the biotechnology action. The larger firm often believes that it will be able to transfer the new technology from a startup much easier if it has significant equity and can exercise some degree of control on the startup. This "power" approach may turn out to be disappointing to the large company as technology transfer is more likely to depend upon the establishment of close personal relationships between the technical staffs of the investor and the investee. Even if it cannot transfer the technology, however, the large firm can realize large capital gains if and when the stock value experiences significant appreciation.

Firms' Investment Strategy. In the U.S. high technology venture industry, foreign investors have become and continue to be important sources of cash

for many fledgling companies. Of the $2.3 billion funds raised by the U.S. startups in 1985, nearly one-quarter came from overseas. Young U.S. companies, dispirited by flagging support from domestic investors, find the foreign link irresistible. (Harding, 1986)

Japanese companies have recently become a substantial funds supplier to U.S. high technology industry. Japanese firms usually focus less upon the cost of the venture than on the future wealth that they hope to reap from the new technology. In trading corporate equity to Japanese firms U.S. start-ups also gain close relationships with them and easier entry to Japanese markets. Through Japanese partners the U.S. startups will be catapulted into Far East markets as soon as they are ready to sell their products. The Japanese investors are reasonably patient, giving the U.S. startups ample time to bring their ideas to fruition, which these young firms need just as badly as cash.

Large Japanese biotechnology firms usually provide capital to U.S. startups through U.S. venture capital companies instead of making direct minority investments, although direct Japanese investments into U.S. firms are growing. (Jubak, 1988) We obtained supplemental data on these activities from mail questionnaires sent to nine biotechnology-related venture capital companies, three of the nine currently including a total of six Japanese corporate investors. In addition many Japanese companies have become members of venture capital consortia formed by Japanese trading companies and supply funds to U.S. venture capital companies, such as Orien Ventures, organized by Mitsui & Co. working with U.S.-based Vista Group, and EG&G Ventures, with which Mitsubishi Corp. is a close collaborator, although these consortia are not specialized in biotechnology-related investments. (Hattori, 1988) Information about the invested new venture companies are provided to all the participating firms which thereby attempt to use the investments as a window on the technology. Recent research indicates that benefits from such potential venture capital fund "windows" are limited by the amount of transfer effort exerted by the investing firms as well as by the attitudes of the venture capital fund managing partners. (Nataranjan, 1988)

On the other hand there are not yet many examples of Japanese firms' direct investments in U.S. biotechnology startups (some are shown in Table 2). Perhaps the main reason is that the Japanese firms that are trying to

diversify into biotechnology are far more interested in obtaining advanced technologies, and not very concerned about realizing corporate capital gains that are not highly valued by the Japanese executive. In order to transfer technologies Japanese firms appear to believe that research contracts and direct licensing are much better because they are quicker, more direct, and more effective than making minority equity investments. (Kumagai, 1988)

Table 2. Japanese Minority Investments in Biotechnology Startups

Japanese Company	U.S. Startup
Chugai Pharm.	Genetics Institute
C. Itoh	Genetics Institute
Fuji Rebio	Biotech Research Lab.
	Hana Biological
Kirin Brewery	Genetics Institute
	Plant Genetics
Mitsubishi Corporation	Biovec Technology
	Sungene Technology
Shin-Etsu Chemical	Syntro

Source: Authors Compilation

However, the recently appreciated yen may change the industry's practice. (Jubak, 1988) To Japanese large firms every new potential investment in the U.S. has become a big bargain since the value of the Japanese yen has almost doubled in the past couple of years against the U.S. dollar. Furthermore, the stock prices of publically-traded startups went down significantly after the U.S. stock market crash of October 19, 1987, making potential investments in U.S. biotechnology firms even more attractively priced to Japanese companies. As many biotech startups are hesitant to or will even forego issuing public stock in the present weakened market, Japanese firms' willingness to commit significant amount of money to U.S. startups enables them to secure large blocks of stock at relatively low prices. (Kenney, p. 207)

Some large Japanese firms that are diversifying into biotechnology have

purchased minority equity positions in pharmaceutical companies and seed firms in order to secure marketing channels. Not many Japanese firms have elected this strategy so far (examples in Table 3), yet equity investments in firms with marketing and sales expertise are likely to become more common as the diversifying firms get further accustomed to the new technology and business.

Table 3. Japanese Minority Investments in Drug/Seed Companies

Investor	Investment
Kirin Brewery	Banyu Pharmaceutical
	Tohoku Seed
Mitsubishi Chemical	Nikken Kagaku
	Nippon Shinyaku
Nissin Food Oil	Kobayashi Pharmaceutical
Toray	Fuji Rebio

Source: Authors Compilation

Licensing

A license is an agreement regarding rights to use a technology, and/or production and/or marketing rights. Licensing rights to the technology and to its production is attractive to companies that are trying to diversify into biotechnology because such agreements allow quick access to advanced technologies and production processes that have already been developed by licensors. As indicated by von Hippel (1988) the attractiveness of licensing tends to be concentrated in the chemical and pharmaceutical industries and does not carry over to electronics, for example. Indeed even in biotechnology the benefits from licensing marketing rights are limited to companies with established sales and distribution channels such as large pharmaceutical companies.

Licensing is a conventional option with relatively low risk. Firms can avoid any financial risk with regard to development of new products and their

production processes. The licensed products have already been proven to be profitable in many cases, enabling firms to enjoy a stable profit from the new products while gaining good insight to the new technology and business. However, there is no way to enjoy high profit with low risk. In the pharmaceutical industry royalties are quite expensive and range between 7% and 12%. (Harrigan, 1985, p. 344)

The major limitation of licensing is that the internal accumulation of expertise is not substantial. Although firms might be able to get experience in a limited technological and/or market area from its rights to a licensed technology, the license itself does not guarantee that large firms will improve their technical competence. (Roberts and Berry, p. 8)

Firms' Licensing Strategy. Licensing has been the stereotyped strategy of Japanese companies for diversification. In the past Japanese companies preferred to purchase foreign patents to save on R&D costs, and made efforts instead to improve process technologies, i.e. manufacture new products of higher quality and at lower cost. At the same time government restrictions helped to protect domestic industry and absorb new technology from overseas through licensing. The Japanese government was reluctant for foreign companies independently to do business in Japan and encouraged through regulations that foreign companies form joint ventures or sign licensing agreements with Japanese companies. (Antebi and Fishlock, 1985, p. 210)

Many Japanese biotechnology companies are also involved in conventionally licensed production of foreign developed pharmaceuticals in Japan. While licensing from foreign startups often involves the license of technologies, production, and marketing, licensing from large foreign firms pertains mainly to marketing and/or production rights. Many agreements with overseas firms include marketing rights for other part of Asia, thereby taking advantage of the experience and distribution channels of Japanese companies in this part of the world. For example, Green Cross has an exclusive license from Biogen to produce the hepatitis B vaccine on the Japanese market, while Yamanouchi has one with Schering Plough for interferon. Daiichi will develop a blood diagnostic test made by Genetic Systems, and will produce and market the kit in the Far East for Genetic Systems, receiving agreed-upon royalties. (Antebi and Fishlock, p. 215)

Through licensing agreements many Japanese companies are trying to scale up production of newly developed pharmaceuticals. Japanese firms already have very advanced fermentation technology, holding over 60% of the world's patents in fermentation process technology. This leadership provides Japanese firms with an important base for mass cell culture technology, essential for scaling up. For example, Snow Brand introduced TPA production technology from Israel's Weizmann Institute and is scaling up in Japan. Toyobo is also constructing a TPA production facility for use with a gene from Integrated Genetics, and Green Cross is scaling up HBsAg production with a license from Biogen. (Nikkei Bio, 1986) As has been true in prior technology-based industries Japan's strategy has been to develop world leading production and process technology, their traditionally strong areas, along with cutting edge biotechnology products.

A recent trend of Japanese biotechnology and pharmaceutical firms is licensing products and technologies to overseas companies, providing evidence that the Japanese have been catching up with foreign companies in technologies. In fact, the Japanese balance of payments for licenses in the pharmaceutical industry began to balance in 1984. (Diamond, 1986) As Japanese biotechnology firms are improving their leading edge technologies, license exports from Japan to the U.S. are expected to increase further.

A caveat of which Japanese firms need to be aware with regards to licensing is that the technology obtainable through these arrangements might not be state of the art, although perhaps not as much as one generation behind. In an industry where technological advantage can amount to a world of difference, no company wants to disclose its sources of competitive strengths to rivals. Once any firm sells its key technologies to present or potential rivals in exchange for relatively small royalty payments, it might lack competitiveness in the future. In a necessarily anonymous personal interview one senior manager of Genetics Institute admitted that the technology they license to outsiders is only "slightly obsolete". Furthermore, they do not make available to outsiders their most advanced production or research technology. Even if they do not intend to transfer an already obsolete technology, the technology cannot remain at the state of the art for very long in a rapidly evolving area such as biotechnology.

Table 4. Major Japanese Licensing Agreements with Foreign Startups

Licensee	Licensor	Product/Technology
Asahi Chemical	Beckman Research	TNF, Alpha-IFN
CST Research	Hybritech	Monoclonal Antibody
Chugai Pharmaceutical	Genetics Institute	EPO
Daiichi Pharmaceutical	Genentech	Alpha-IFN
	Genetic Systems	Diagnostic Kits
Fuji Rebio	Celltech	Monoclonal Antibody
	Integrated Genetics	DNA Probe
	Technoclone Interntl.	Monoclonal Antibody
	Hana Biological	Testing Kit
Fujisawa Pharmaceutical	Genentech	TNF
Green Cross	Biogen	HBc
Kirin Brewery	Plant Genetics	Synthetic Seeds
Kuraray	Xenogen	DNA Probe
	Calgene	Agri-Chemical
Kyowa Hakko	Genentech	TPA
Nippon Kayaku	No. Amer. Biologicals	Alpha-IFN
Nippon Medi-Physics	Centocor	Monoclonal Antibody
Mitsui Toatsu	Beckman Research	TPA
Mitsubishi Chemical	Hybritech	Monoclonal Antibody
	Genentech	TPA, HB
Sankyo	Celltech	TPA, TNF, MAF
Sekisui Chemical	Cetus	Monoclonal Antibody
Shionogi	Molecular Genetics	Monoclonal Antibody
Snow Brand	Weizmann Institute	TPA
Suntory	Biogen	TNF
Takara Shuzo	IQBio	Monoclonal Antibody
Toray	Genentech	Alpha-IFN
	Centocor	Monoclonal Antibody
Toyo Soda	Unigene	Monoclonal Antibody
Toyobo	Integrated Genetics	TPA
Yamanouchi Pharm.	Biogen	Alpha-IFN, Hormone
	Genetics Institute	TPA
Yoshitomi Pharmaceutical	Genex	IL2

Source: Authors Compilation

Table 5. Major Japanese Licensing Agreements with Foreign Large Firms

Licensee	Licensor	Product/Technology
Kumiai Chemical	Merck	Antibody
Mitsubishi Petrochem.	Abbott	Urokinase
Nippon Kayaku	Hoechst	Tissue Culture
Shionogi	Eli Lilly	Insulin
	Merck	HB, Antibody
Sumitomo Chemical	Rohm & Haas	Hybrid Rice
Sumitomo Pharmaceutical	KabiVitrum	Growth Hormone
	Wellcome	TPA, Alpha-IFN
Takeda Chemical	Hoffman-La Roche	Alpha-IFN
Toyobo	Du Pont	G5-CNP
Yamanouchi Pharm.	Schering Plough	IFN

Source: Authors Compilation

Table 6. Major Japanese Licenses to Foreign Companies

Japanese Licensor	Licensee	Product/Technology
Ajinomoto	Hoffman-La Roche	IL2
Kyowa Hakko	Ciba Geigy	Alpha-IFN
Sankyo	Squibb	CS-514
Suntory	Schering-Plough	Alpha-IFN
Taisho Pharmaceutical	Abbott	TE-031
Takara Shuzo	Amersham	Pst1, RNAseH

Source: Authors Compilation

Corporate Alliances

Corporate alliances, which are resource-aggregating and risk-allocating

alternatives (Harrigan, p. 29), are quite common in the biotechnology industry where both high risk exists and intensive multi-dimensional competition (e.g., technologies, sales and marketing, financial ability) determines eventual successful commercialization. Corporate alliances allow firms to combine their comparative strengths and overcome weaknesses, while minimizing uncertainty and expenditures by all partners. (Roberts, 1986)

The two types of corporate alliances that are prevalent in the Japanese biotechnology industry are joint research projects and formal joint ventures. One main difference between the two is whether new corporate entities are founded or not. Because of this difference, each option allows similar but slightly different strategic implications. Corporate alliances are an intermediate alternative between internalization of business expertise and technologies, by either acquisition or internal development, and total dependence on outsiders, such as through licensing and contract research. Alliances provide firms more flexible means of accessing technology and enhancing innovation than wholly inhouse R&D or acquisitions. They allow large firms to diversify into attractive but unfamiliar businesses with limited investment risk. (Harrigan, pp. 33-35) Citing data presented by Okumura, Technology Strategies recently reported a rapid increase of Japanese alliances, especially in biotechnology. (Technology Strategies, 1988)

Joint Ventures

A joint venture is a new entity established by two or more parent firms in order to achieve a special objective, such as the development of a new technology and/or the marketing of new products. In many cases the parent firms not only invest capital but also assign employees to the new joint venture. The management and operation of the joint venture are performed by those who work in that new venture, and each parent firm exerts a strong influence on those people as both a major investor and sometimes as their permanent employer.

In high technology industries such as biotechnology, "new style joint ventures" where a large, established firm and a small entrepreneurial firm form a collaboration for development and commercialization of a product are

increasingly becoming important. In this collaboration small companies provide advanced technologies and large firms provide marketing and financial ability. (Roberts, 1980) An example is a pharmaceutical production venture by Genetics Institute and Wellcome. Joint ventures, whether of more conventional form between two firms or of the less formally structured "new style", not only allow firms to combine strengths of their parents but also to enter new businesses more easily and with less risk than via inhouse developments and acquisitions. Joint ventures might also help create a innovative distinct physical environment that is different from the research facilities of the large parent corporations.

Harrigan indicated that positive "bleedthrough" is one of the major benefits from joint ventures. She defined bleedthrough as knowledge gained by working with partners on joint ventures. She noted that some firms formed joint ventures to gain knowledge, skills, and technology which they hoped to transmit back to their parent organizations. When partners' scientists work together in a joint venture to develop products, partners may devote efforts to parallel research experiments in their wholly owned laboratories to learn more about their partner's technological approaches. Firms also can rotate scientists between the joint venture and their own laboratories to disseminate information. (Harrigan, p. 345)

One drawback of a joint venture is the possibility of conflicts of interest, sometimes happening simply because each parent might have a different interest and objective in the joint venture. In addition, differences in corporate culture and management styles of the parents might lead to disharmony in the joint company. (Roberts and Berry, p. 8)

Firms' Joint Venture Strategy. Biotechnology joint ventures by Japanese companies can be classified into two types: resource accumulation ventures and resource complementing ventures. Resource accumulation joint ventures allow several comparable companies, within a related area, to pool their technologies, human resources, and financial ability to develop new common technologies or even specific new products, with significant savings of time and resources to each participant. The Biomaterial Laboratory venture by Toray, Kuraray, and Sumitomo Denko, and the joint venture to develop and produce active peptide by Meiji Seika and Dicel are examples. The Sagami

Chemical Research Center was formed mainly by five chemical companies under the guidance and financial assistance from the Industrial Bank of Japan, and Green Research Development Center will be established by the Sanwa Group companies. These examples provide an interesting view of Japanese business arrangements, i.e. a close relationship within a business group with a leading role being played by a major bank.

Resource complementing joint ventures are more common alliances in which several companies, each offering a different strength, combine their efforts. This type of joint venture is desirable and often necessary when firms enter international markets and must compensate for their present weaknesses in international distribution channels. For example, Ajinomoto is associated with the French company Orsan in the production of lysine, and this association will soon lead to construction of a new lysine plant in the United States. Similarly Tanabe Pharmaceutical and Marion Laboratories are about to form a joint venture with the hope of developing, patenting, marketing, and manufacturing in the U.S. some of the pharmaceutical products currently manufactured by Tanabe in Japan. (Antebi and Fishlock, p. 215)

Another characteristic of Japanese business which can be seen in the resource complementing joint venture is the involvement of Japanese trading companies in the new business. Mitsubishi Corporation established the Plant Engineering Laboratory with Mitsubishi Chemical; Sumitomo Corporation founded Nippon Men'eki with Yamasa Shoyu; and Tomen founded T.M. Ball Laboratory with G.J. Ball and Mikado Seed. In these joint ventures trading companies provide funds, marketing channels and technical information generated through their world wide information gathering.

Joint Research Projects

Joint research projects provide a looser basis for collaboration than formal joint ventures. Joint research allows more flexibility, easy formation and easy termination. No equity investment or establishment of new organizational entities is needed. Two or more companies just cooperate and coordinate efforts to tackle the same problem. Experiments may be performed jointly in one participant's laboratory where scientists from participating companies can work together, or independently in each

Table 7. Major Japanese Joint Ventures

Joint Venture	Parent Companies	Project
Resource Accumulation Type:		
Bio Material Lab.	Toray, Kuraray, Sumitomo Denko	Bio Material
Meiji-Dicel	Meiji Seika, Dicel	Active Peptid
Sagami Chemical Research Center	Toyo Soda, Nippon Soda, Central Glass, Nissan Chem. Hodogaya Chemical	Recombinant DNA Protein Engrg.
Mitsui Inter-Ind. Lab.	Mitsui Toatsu, Oji Paper, Mitsui Petrochemical	Biotechnology
Resource Complementing Type:		
BW Biotech	Toyo Engrg., Bernard Wolnak	Biotechnology
Eurolysine	Ajinomoto, Orsan	Aminoacid Prodctn
Kirin-Amgen	Kirin Brewery, Amgen	EPO
Nippon Men'eki	Sumitomo Corp., Yamasa Shoyu	Immunology
Plant Eng. Lab.	Mitsubishi Chem.,Mitsubishi Crp.	Plant Engineering
Sumitomo-Nelson	Sumitomo Corp., Nelson R&D	Sales and Distrib.
Takara-Orgenics	Takara Shuzo, Orgenics	DNA Probe
TAP Pharmaceutical	Takeda Chemical, Abbott	Sales and Distrib.
T.M. Ball Lab.	Tomen, G.J. Ball, Mikado Seed	Seed Development
Toray-Fuji Bionics	Toray, Fuji Rebio	Sales and Distrib.
Yamanouchi-Sterling	Yamanouchi Pharm., Sterling	Sales and Distrib.

Source: Authors Compilation

participant's laboratory combined with regular technical meetings to pool research results and exchange information. The latter pattern is more common because of corporate secrecy. Patents from joint research are usually held jointly among participants.

For companies which want more to advance knowledge than to obtain it, joint research projects are also very useful. Joint research projects offer opportunities to exchange expertise and a place to pool ideas and information without the troublesome procedures required when new entities are established. They also allow participating companies to save unnecessary expenses from duplicated efforts on the same R&D.

Joint research projects among private Japanese companies differ from the well-known Japanese government financed joint research consortia. While companies are in many cases invited to participate in the government projects, firms voluntarily form private research projects. Consequently, some firms are reluctant to participate in the government research consortia, but less frequently hesitate to participate in private research projects. The resulting motivation is higher and conflict of interest is perceived to be lower in private joint research than in the government projects, promoting faster research progress in the private joint research projects.

Firms' Joint Research Strategy. Many Japanese companies that have already established good familiarity with biotechnology are entering into joint research collaborations in order to develop many new technologies. In the pharmaceutical industry special expertise in toxicology and in conducting clinical trials is needed for the successful introduction of a new drug, as well as skills in production technology and marketing. In contrast, in the new seed business access to plant and seed libraries alone may be sufficient keys to success. However, companies which recently entered these businesses have not yet developed any comparable expertise, resources, and marketing channels for their new drugs, seeds and plants. Rather than taking the considerable time and money to develop these strengths internally, many companies have decided instead to form partnerships with companies that already had established business expertise in these areas.

Therefore, as indicated in Table 8, joint research with the firms that have established business resources, i.e. drug companies in the pharmaceutical business and seed firms in the plant engineering business, has become quite prevalent in Japan. In many of these collaborations the firms with technologies expect the firms with business expertise to help them in commercializing the technologies, i.e. launching new products into the market

place. Through friendly relationships with these companies technology firms also expect to learn business management skills in the pharmaceutical and seed industries for future internalization. (Umesawa, 1983)

These joint research projects are most likely to produce sales licensing agreements between firms with technology and firms with business resources. Japanese pharmaceutical companies have large sales forces called "Propa (propaganda)" who have strong educational backgrounds in general pharmacy as well as sales techniques. Joint research projects provide easy access to these powerful sales forces and marketing channels as well as to business expertise. The president of Morinaga Milk conceded, "We cannot do without the collaboration with pharmaceutical companies for the commercialization of biotechnology." (Nikkei Sangyo Shinbun, 1987) As shown in Table 8, either pharmaceutical companies or seed firms (both printed in italics) are involved in many joint research projects. As many firms had initially transferred original technologies from U.S. startups, a typical corporate alliance of Japanese non-pharmaceutical firms looks like Figure 1.

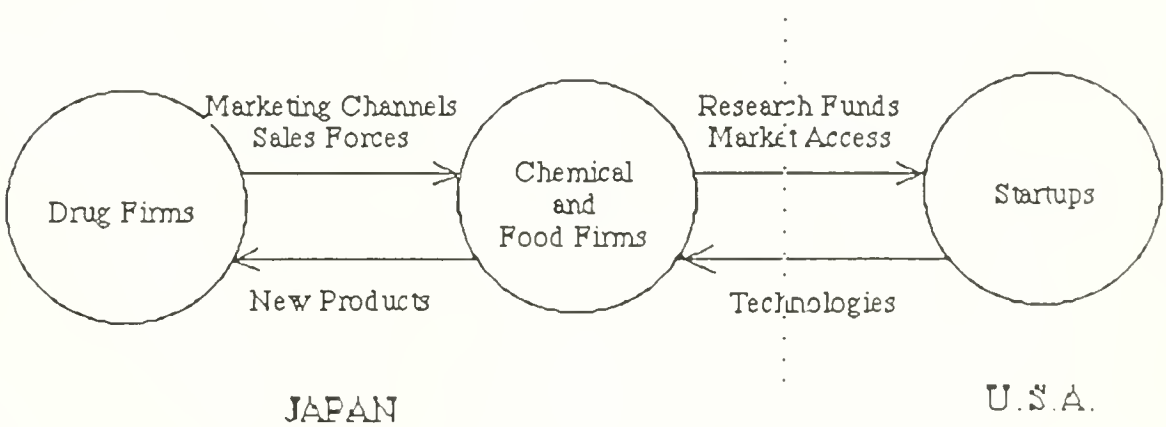

Figure 1. Structure of Typical Japanese Corporate Alliance

Table 8. Major Japanese Joint Research Projects

Partners (*Italics* indicates seed or pharmaceutical company)	Project
Ajinomoto, *Yamanouchi Pharmaceutical*	Anti Cancer
Asahi Chem., *Kowa*	TPA
Asahi Chem., *Dainippon Pharmaceutical*	TNF
Dainippon Ink, Takara Shuzo	Enzyme
Dainippon Ink, Nikki	Bioreactor
Green Cross, Ishihara Industries	Anti Cancer
Green Cross, Morinaga Milk	CSF-HU
Green Cross, *Ono Pharm.*	PG12
Green Cross, *Taisho Pharmaceutical*	(PG)E1
Japan Synthetic Rubber, Hana Biologicals	Mass Cell Culture
Kikkoman, *Daiichi Pharmaceutical*	Hormone
Kirin Brewery, *Tokita Seed*	New Vegetable
Kirin Brewery, *Tohoku Seed*	New Vegetable
Kirin Brewery, *Mikado Seed*	New Vegetable
Kuraray, *Kayaku Antibiotics, Yamanouchi*	DDS
Kyowa Hakko, Ozeki Sake Brewing	Bioreactor
Kyowa Hakko, Kurita Ind., Toyo Engnrng.	Biomass Alcohol
Meiji Seika, Sanraku	THP
Mitsubishi Chemicals, Snow Brand	EPO
Mitsubishi Chemicals, *Fuji Rebio*	Non HB Vaccine
Mitsubishi Petrochemical, Hagiwara Lab.	Monoclonal Antibody
Mitsubishi Yuka, *Japan Pharmaceutical*	Monoclonal Antibody
Mitsui Petrochemical, *Daiichi Seed*	Cell Fusion
Morinaga, Toyo Soda	Monoclonal Antibody
Nissan Chemical, Fuji Chemical, Zen'no	Growth Hormone
Nissan Chemical, *Japan Polio*	Vaccine
Nissin Flour, Oriental Yeast	Vector
Nippon Kayaku, Yamasa Shoyu	Anti Cancer
Nippon Chemical Feed, *Mochida Pharm.*	EPA
Nippon Suisan, *Mochida Pharmaceutical*	EPA
Plant Engineering Lab., *Kyowa Seed*	Tissue Culture
Sapporo Breweries, Dicel	RBS

Sumitomo Chemical, *Sumitomo Pharm.*	Monoclonal Antibody
Taito, Sun Star	Tissue Culture
Taiyo Fishery, *Daiichi Seed*	Mass Cell Culture
Teijin, *Yoshitomi Pharm.,Wakunaga Pharm.*	TNF
Teijin, *CTS Research*	Vaccine
Toray, *Daiichi Pharmaceutical*	Beta-IFN
Toray, Takara Shuzo	Amino Acid
Toyobo, *Ono Pharmaceutical*	CEA
Toyo Jozo, Kurita Industries	Antibody

Source: Authors Compilation

It is noteworthy that many of these joint research projects are entirely domestic within Japan. Although Japanese firms want to engage in joint research projects with U.S. startups which have more advanced technologies, these attempts have not yet been successful. Geography is one reason. It is not easy to keep a good two-way flow of information, human resources, and material across the Pacific Ocean. Another important reason is the attitude of the U.S. startups toward their secret proprietary technology. No firm wants to transfer its most important competitive advantage, superiority in technologies, through joint research projects. (Kumagai, 1988) In contrast, however, are the large number of sponsored research projects, funded by Japanese companies at least in part, but carried out wholly by the U.S. startup firms, as indicated previously in Table 1. These suggest that U.S. firms may be willing at the "right" price to sell the results of their R&D for Japanese firms to exploit, but are more reluctant to permit access to technological knowhow that would enable a Japanese firm to compete more directly in the future in creating new products.

Acquisitions

Acquisition is the quickest way to obtain a new technology or enter a new market. This approach instantly internalizes all expertise that a firm may be seeking. In the biotechnology industry two kinds of companies have been the major target of acquisitions: the pharmaceutical company with marketing expertise and a biotechnology startup having advanced technology.

Even for financially well off large companies, building up a marketing network and sales force is an extremely time consuming and large investment. In many cases it is less expensive and in all cases it is less time consuming to take over a company that has an established marketing network. This motive was cited when Monsanto purchased G.D. Searle Company for $2.7 billion, and again more recently and even more expensively when Eastman Kodak purchased Sterling Drug for $5.5 billion. But the opportunities for decisions of this magnitude are rare.

Acquisitions of biotechnology startups, as in the purchase of Hybritech

by Eli Lilly and Genetic Systems by Bristol-Myers, often evolve from a minority investment. A significant early capital investment provides a good base from which a large company might eventually launch a takeover attempt.

The price of biotechnology companies is usually very high. Venture capitalists will sell out their stakes only if the buyout provides significant capital gains or if the company is weak and is in reality being rescued by purchase. Also acquisition of startups are sometimes resisted by founders and the scientists working for the startups. Although large firms can sometimes purchase entire startups in spite of the resistance, such a takeover usually results in key scientists leaving the company. As the startup's most important corporate asset is usually its technical manpower, the departure of highly qualified scientists as a result of a hostile acquisition devalues the investment quite badly.

Firms' Acquisition Strategy. Major Japanese biotechnology companies have purchased or are looking for merger and acquisition targets in the pharmaceutical industry to acquire market channels, sales forces and business expertise. Sumitomo merged with a medium-sized pharmaceutical firm, Inaba Industry, and established a new company, Sumitomo Pharmaceutical. Ajinomoto became the controlling stockholder of Morishita Pharmaceutical, and Mitsubishi Chemical purchased majority equity in Tokyo Tanabe Pharmaceutical. (Toyo Keizai, 1987)

One of the obstacles to acquisition of a drug company is its high price. Although stock prices world-wide dropped substantially after the October 19th market crash, purchasing controlling equity in a drug company is still not a small investment. Another obstacle, which is more important within Japan, is that many Japanese pharmaceutical firms are privately owned or a majority of the stock is controlled by owner families. This second obstacle is also true in the Japanese seed industry. It is almost impossible to purchase well-managed Japanese family-controlled firms. Also it is very difficult to make a successful acquisition among limited number of candidates because the same firms are being considered as acquisition targets by many firms.

On the other hand no Japanese firm has yet purchased a U.S.

biotechnology startup. Some possible reasons are:

1. It is less risky and more beneficial to have a portfolio of research contracts and licensing activities with many startups than to purchase a single company;
2. Japanese firms are afraid of losing key scientists and researchers, the most important intangible assets of U.S. startups, after the company has been acquired;
3. Prices of startups had been extravagant. (This factor has lessened in importance since the stock crash.)

Therefore, it is not likely that Japanese large firms are going to acquire many U.S. biotechnology startups, although in a few cases it might actually happen. Rather Japanese firms will probably prefer to establish their own U.S. laboratories, as Otsuka Pharmaceutical did, where they can employ more innovative U.S. scientists at a reasonable cost because of the favorable exchange rate. In a recent poll 87 Japanese firms in high technology industries indicated they are considering establishing laboratories in the U.S., and 27 have already done so. (Nippon Keizai Shinbun, 1987)

Conclusions

Several trends are expected with respect to inter-firm collaboration strategies in the Japanese biotechnology industry. The first is that a stable and not increasing amount of research will be contracted out to U.S. startups. Although the contract research option would probably decrease in popularity as Japanese firms become more established in new businesses and technologies, the highly appreciating yen will dramatically change the cost/benefit balance between internal development and contracting-out and/or licensing. The fact that R&D costs incurred in dollars are becoming increasingly less expensive in terms of yen is offsetting the movement of technological internalization.

The second trend will be the increase of technology licensing by Japanese firms to foreign companies. This should occur as the level of Japanese biotechnology catches up to the U.S. Because of the high cost of

developing world-wide marketing forces and channels, it is unlikely that Japanese firms will establish world-wide distribution systems by themselves. Instead they will continue to use foreign companies' sales and distribution networks through licensing agreements, even if Japanese firms should succeed in scaling up and producing better biotechnology products at less cost.

The last expected trend is for some increase in the acquisition of Japanese domestic pharmaceutical companies and seed firms. Although this is not likely to occur with great frequency because of the several mentioned restrictions (costs, limited number of candidates), many large Japanese firms have at least begun to consider this option seriously. On the other hand the difficulty of integrating an acquisition makes corporate collaboration with drug companies and seed firms even more important for successful commercialization of the technology.

Many firms have placed emphasis on increasing their internalization of technology and marketing expertise while making current strategic use of inter-firm collaborations. Because of the technological and marketing complexity of the biotechnology industry, it is unlikely that Japanese firms will completely substitute in-house R&D and acquisitions for the varied forms of corporate alliances that have been discussed. Furthermore, the potential effect of the appreciating yen should be carefully noted with regard to Japanese companies' collaborative strategies. Their improved purchasing power will allow Japanese firms to buy U.S. advanced technologies which, combined with Japanese world leading scale up techniques, would assure growing Japanese competitiveness in the evolving biotechnology industry.

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